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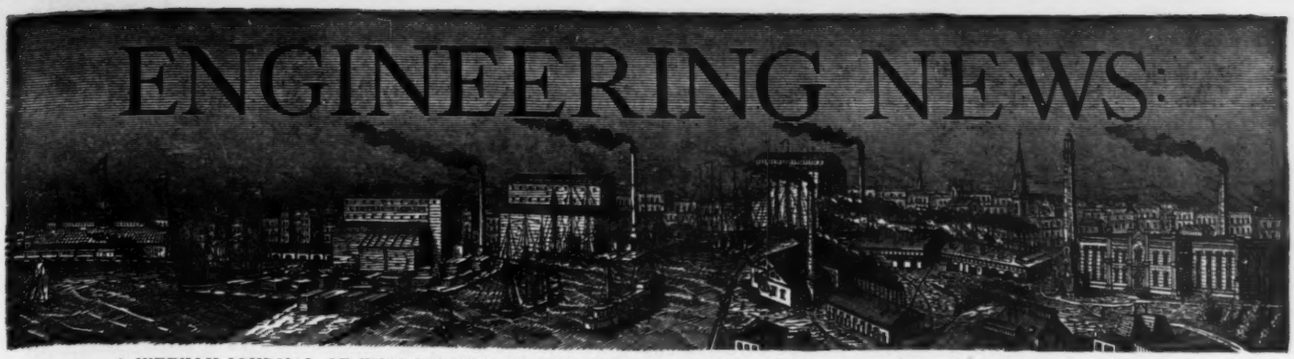
ENGINEERING NEWS.



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CIVIL ENGINEERS' CLUB OF THE NORTHWEST.

Report of April Meeting.

The 65th regular meeting of the Club was held at the Sherman House Club rooms on Tuesday the 4th inst. beginning at 4 o'clock P. M; President Chesbrough in the chair and a large attendance of members, including several non-residents. After the approval of the minutes of the last meeting the following persons were elected members: A. Case, 38 Portland Block, Chicago; G. F. Kirby, 420 5th Avenue, Chicago; C. J. Roney, Chicago University; Henry Stewart, associate editor *American Agriculturist*, New York City; W. H. Newton. Chicago. Mr. Greeley read a partial report of the Committee on the Adoption of the Metric System of Weights and Measures, which was accepted and the Committee continued. By request of the President R. J. McClure, C. E. of the C. B. & Q. Ry. was added to the Committee, and on motion it was resolved that the next regular meeting be set apart for the discussion of the Metric System. Paper by C. J. Quetil, C. E., of Camden, N. J., and by W. Sooy Smith, C. E., of Maywood, Ills., were read, and that of Mr. Quetil on the "One Rail" system of railway was discussed by Chas. Paine, Past President, President Chesbrough, the Secretary, and other members. An abstract of Mr. Quetil's paper is given in another column and the paper of Mr. Smith is given in full.

The President read a letter from a gentlemen in Tennessee, relating to the "Water Witching," corroborating Mr. Latimer's experiences by his own observation made during the past fifty-three years (he being now 73 years old) but acknowledged his inability to explain the cause of the phenomena of the divining rod. A communica- from W. Milnor Roberts, Chairman of Sub Committee on Finances of the American Society of Civil Engineers, was read. Mr. R. stated that only a comparatively small number of responses had been received in reply to the circulars requesting contributions in aid of the Centennial fund and not more than one-third of the amount necessary to pay the expenses attendant upon the exhibition of engineering had been secured; the Committee had therefore felt it necessary to address personal letters to the various Engineering Societies and to individual members urging immediate action and liberal contributions in aid of the fund.

President Chesbrough called the attention of members to the importance of the proposed exhibit by the American Society, which society might be considered the national representative of the profession at the Centennial, and invited co-operation. Mr. Chas. Paine, of Cleveland, Past President, called attention to the fact that not only were the members of the American Society contributing liberally of their funds but that they were performing a great deal of gratuitous labor and it was certain that an exhibit creditable alike to the country and the profession would be made at Philadelphia during the coming summer. On the motion of D. C. Cregier the Secretary was instructed to contribute from the funds of the Society, $200 towards the Centennial fund, and to provide the funds the Secretary was instructed to call in the dues of members for the current year; those members who had been elected during the year to be called on for amounts prorata to the time at which they were elected. A letter from Major Jared A. Smith of the U. S. Engineers stationed at Key West, Florida was read. Major Smith's letter was accompanied by detail drawings and specifications of an "Iron Light House to be placed over Stair Tower of Bastion C., in Ft. Jefferson, Florida," and sent as a donation to the Club.

The Secretary read a memorial presented by J. Sooy Smith, of the U. S. Board for testing Iron and Steel petitioning Congress to continue the appropriation to the Commission and asking the concurrence of the Club. The memorial was adopted, after which the Club adjourned.

METHOD ADOPTED FOR PUTTING IN THE PIERS OF THE BRIDGE OVER THE MISSOURI RIVER AT BOONEVILLE. By W. Sooy Smith, C. E.

As some little thing done by an engineer in the construction of difficult work often proves the germ which he and his fellows afterward nurture and develop into processes and systems of great value to his profession and to the world: I ask your consideration of this description of a method employed to found a masonry pier on rock bottom in deep water, and to build it up to water surface; as it was new to me, succeeded perfectly, was very economical in time and money, and resulted in the construction of piers of great strength and durability.

While building the bridge across the Missouri River at Booneville, it became necessary to construct the pivot pier of the draw span, and the one next south of it, upon a slightly undulating rock bottom, in fifteen feet of water at ordinary stage. The inequality of the surface of the bottom amounted to about two feet from the highest to the lowest point occupied by the pivot pier. Beneath the other pier it was less. During low water the current was quite gentle, not exceeding two and one half miles per hour and when the current had this low velocity there was a deposit of sand upon the bottom sometimes reaching the depth of two feet. During freshets the current sometimes reached six miles per hour and then the rock was swept bare.

To make a water-tight cofter dam in the ordinary way upon a rock bottom in water fifteen feet deep would have been very difficult. To prepare the bottom to receive the masonry laid in the old fashioned caisson way would have been very expensive. The following plan was therefore adopted.

The exact outline of each of the piers was described on the ice while the river was frozen over and an accurate sounding was taken every two feet on this ground plan.

A crib eight feet in height was then framed consisting of 12"x13" timbers put together and thoroughly drift bolted. The bottom of the crib was made to fit the rock upon which it was to rest. The inside space was divided into compartments about eight feet square each by partition walls consisting of 12"x12" timbers well drift bolted. These partition walls were only carried down to a level two feet above the bottoms of the exterior walls, to allow for any inequalities that might exist in the surface of the rock, upon which a partition wall might otherwise have rested before the crib had reached its proper position and bearing.

When so far completed the crib was towed into the stream and moved nearly into position by means of anchorages surmounted by a strong frame work calked and forming a water-tight cofter dam, which should rise a sufficient height above water when the crib rested on the bottom to prevent an overflow by a sudden rise in the river.

A platform rested on the frame work of the cofter dam upon which stone was deposited to load and sink the crib. This stone was afterward used in the construction of the pier, and so the loading of the crib required no expense for labor or materials. As the stone was placed upon the platform and the crib sunk, just as the structure began to rest upon the bottom, it was carefully pulled into the exact position it was to occupy and held there until it was thoroughly grounded. The crib was so designed as to project beyond the pier at its base two feet all around, except on the up-stream side where its pointed end extened fourteen feet beyond the masonry.

The first attempt at sinking the pivot pier was made during the winter time when the river was low and the current so gentle that there was a deposit of sand upon the rock two feet in depth. This deposite was soon cut from under the up-stream end of the crib by the increased scour of the current produced, and an increased thickness of sand was deposited in the center, and at the down stream end of the structure, causing it to tip toward the up-river side at a considerable angle.

This was anticipated and, we thought, provided for. We had a powerful rotary pump and a six inch steam syphon in readiness and with these we undertook to remove the sand from beneath the crib. We did remove perhaps three times the quantity that existed there when we commenced pumping; but it was replaced by other sands brought in by the current as fast as we could remove it. We then attempted to wash away the sand by means of water jets—and with these we could remove the sand rapidly but only over an area too limited to prevent our crib to sink. The river was frozen over during these operations, the ice being about one foot in thickness blue and solid. The temperature then rose as did the river also. The ice was broken loose from the shores and came down the river in fields extending from shore to shore and from bend to bend in the river. This ice carried away all the upper framing of the cofter dam and the platform holding the ballast or loading of the crib, and the latter relieved of its load, rose and floated a mile and a half down stream where it lodged on a sand bar. Here it was taken apart with extreme difficulty and brought back to the bridge site and put together again.

Profiting by this experience we got everything in readiness and waited the arrival of the spring freshets to lay the rock bare. When these came, we again moved our crib into position and sunk it upon the bare rock without difficulty. We then threw in small stones to the depth of about one foot around the outer wall of the crib, inside and outside, to prevent the wash of a current under the bottom.

The compartments of the crib were next filled with first-class concrete consisting of the spawls from our stone yard, broken so as to pass through a three inch ring, and hydraulic mortar made of one part of the best Utica cement to two parts of sharp sand.

This concrete was laid under water by means of a spout or tremie sixteen feet long and 16"x16" on the inside at bottom and two inches smaller each way at the top. It was made of two inch plank strengthened by cleets 2'x4' every two feet, with smooth planed surface on the inside and surmounted by hopper into which the concrete was thrown with shovels.

Three gangs of men mixed cement in as many different boxes, and it was thrown from each box as soon as mixed in the tremie, through which it decended to the bottom.

At the commencement of the operation the tremie, suspended so as to be easily handled, was lowered upon the bottom and held there until it was quickly and completely filled. It was then raised slightly to permit the concrete to escape at the bottom. As soon as it commenced to do so the work of filling at the topwas resumed and the tremie so controlled as to keep the concrete flowing steadily as it was supplied. In this way we prevented the setting of the material in the tremie and by moving this slowly at the bottom we distributed the concrete evenly and without causing it to fall through the water and separate the mortar from the stones.

Having filled all the compartments of the crib to within one foot of the top the concrete was permitted to remain undisturbed for ten days to give it time to set thoroughly.

At the expiration of this time the water was pumped out of the cofter dam and the top surface of the concrete leveled and carefully prepared to receive the masonry. The concrete was found so hard that it was with difficulty that it could be removed with a pick, and the bottom of the cofter dam was made water tight by it. Proving that it was of excellent quality at all points; for if there had been defects anywhere the water with the pressure of seven to eight feet head would have found them.

The concrete having been nicely tested, the masonry was commenced upon it and soon carried above high water surface. The upper work of the cofter dam was then used for the base of the scaffolding employed in the construction of the pier and only removed when it was completed.

We had thus a pier of first-class masonry resting upon a concrete foundation enclosed in solid walls of timber twelve inches thick thoroughly drift bolted and tied through and through by the cross walls which were framed into the outer wall with dove-tail joints and secured to them by drift bolts. The timber work of this foundation is always under water and below the destructive action of ice. Its strength is greater and its band stronger than that of masonry—it is equally durable and the filling of such compartment is a monolith—and all these huge stones are united by the common base of concrete two feet in thickness upon which they rest and by the wooden walls which enclose them.

The second pier built in this same way was put in without the slighest accident or difficulty.

CONSTRUCTION OF A MASONRY DAM.

BY J. JAMES R. CROES, C. E.

From the Transactions of the American Society of Civil Engineers, New York.

PRELIMINARY.

The dam described in the following paper was constructed on a branch of the Croton river, in Putnam county in the State of New York, by the Croton Aqueduct Board, the department of the government of New York city which was charged with the construction and maintenance of works for the supply of water to the city.

The object of the dam was the creation of a reservoir for storing water to supply the deficiency in the daily yield of the stream, which existed during the summer months of dry years, the minimum flow being not more than four million cubic feet per day, while the consumption had reached double that amount, and was rapidly increasing.

The necessity for artificial storage reservoirs had long been foreseen by Mr. Alfred W. Craven, the chief engineer and a member of the Croton Aqueduct Board since its organization in 1849, and in 1857–58 he had caused a topographical survey of the water-shed of the Croton river to be made, with a view to determine available sites for such reservoirs. The surveys showed that fourteen such sites existed; but not until April, 1865, was the requisite authority procured from the Legislature to construct a storage reservoir.

Nearly a year was consumed in careful examination and comparison of sites, and on March 17th, 1866, it was determined to build a reservoir at Boyd's Corners on the west branch of the Croton, 23 miles by the course of the stream from the Croton Dam, where the aqueduct begins which conveys the water to the city.

The reservoir as constructed here, has a water surface of 279 acres, a maximum depth at the dam of 57 feet, a mean depth of 30 feet, and a capacity of 364,000,000 cubic feet.

At the site selected for the dam, the hills enclosing the valley approach each other, leaving at the level of the stream a space of only 200 feet in width, and at 70 feet above the stream, 700 feet. The centre line of the dam is at right angles to the axis of the valley at this point, and bears nearly north-east and south-west.

The north-easterly hill-side was covered with large slabs of a very compact and fine and even-grained gneiss, piled one upon another, varying in thickness from 6 to 60 inches The rift of the stone was at right angles to the bed on which it lay, the slabs were at an angle of 10°, and the general slope of the hill was 16½°. The ledge underlying the slabs was of much the same character, but not quite so fine grained. The general surface was smooth, and sloping at the inclination of the hill. Occasional seams were found to run in nearly horizontally, from 5 to 20 feet, then apparently terminating abruptly. The surface slabs made excellent stone for cutting where they were of sufficient thickness to give the requisite beds. It was found impracticable to quarry out of the ledge, good stone for cutting.

At an elevation of 15 feet above the stream, the rock was overlaid with about 10 feet of drift, or compact gravelly earth, containing about ten per cent. of its bulk of large boulders, The flat ground through which the stream flowed was swampy on the surface, underlaid by some blue clay, beneath which was a mass of loose boulders and cobble stone, which was succeeded by coarse gravel and sand which extended to the rock, and through which a considerable amount of water percolated.

The south-west hill, rising at an angle of 22°, was composed of compact gravel and boulders, overlying a very fine grained unstratified hard blue rock. The surface of this rock was smooth, but its profile irregular and in benches. It lay at a depth of from 5 to 15 feet below the surface of the ground. In the centre of the valley the two classes of rock seemed fused together, no marked seam separating them. The rock here was 18 feet below the stream level.

No dam at this place could be made safe or water-tight, without removing all the natural material and founding the structure on the rock. All the earth within a mile of the dam site contained so large a proportion of boulders and course gravel as to render it unfit for water-tight embankment, except at enormous expense for separating and screening out the stone. An earthern embankment would have demanded for safety, a tunnel through the rock of the hill-sides for the discharge-pipe at the stream level, and a rock cut of some 15,000 cubic yards in the hill-side at flow line, for waste water.

The stream was liable to sudden and severe freshets which could not be prevented from overflowing the dam during construction. Such a freshet would necessarily destroy a partially completed earth embankment.

An abundant quantity of stone of excellent quality lay on the hill-sides within a short distance of the dam site.

These considerations led to the decision that the dam should be of masonry. Below the level of the stream, the foundation is composed of concrete in which are imbedded large unwrought stones. Above the stream level, the concrete hearting is faced on both sides with coursed stone with cut beds and joints, for 15 feet above the stream, large unwrought stones are imbedded in the concrete; and above that elevation, the hearting is entirely composed of concrete of small stones.

FORM AND STABILITY.

The form of a trapezoid with a vertical face opposed to the water, was adopted, as affording the requisite stability with the least amount of material and least difficulties of construction. The form and dimensions of the wall are shown in Fig. 1. The notation used is as follows:

h = height of wall, or distance from top to any bed joint.

a = top width of wall

α = angle of inclination of face of wall, to the vertical.

b = width of wall at any bed joint at the distance h below the top $= a + h.\ tan.\ \alpha$.

d = horizontal distance of the centre of gravity of the section of the wall, from the vertical face. For a homogeneous wall of this form, $d = \frac{1}{3}\left\{a + \frac{b^2}{a+b}\right\}$.

P = pressure of water on the vertical face $= \frac{h^2}{2}$ when the weight of a cubic foot of water is taken at unity.

σ = specific gravity of the material of the wall.

W = weight of wall $= \frac{\sigma h}{2}(a+b)$.

θ = angle of inclination to the vetrical of the resultant of pressures; $\therefore tan.\ \theta = \frac{P}{W}$.

m = ratio which the distance from the exterior edge of the bed joint to the point where the resultant of pressures interects that joint, bears to the whole width of the joint or b; $\therefore m = 1 - \frac{d + \frac{1}{3} h.tan.\theta}{b}$ To insure there being no tension on any part of the bed joint, m must not be less than 0.333. In practice, English engineers are said to adopt as a safe value $m \geq 0.125$, while the French engineers adopt the limit $m \geq 0.2$. In the calculations for this dam, the limit is taken $m \geq 0.25$.

n = the ratio which the deviation of the centre of pressure at a bed joint, from the perpendicular let fall from the centre of gravity, bears to the whole base. This ratio is the same as $(q + q^1)$ used by Rankine. From the figure $n = \frac{h}{3b} tan.\theta$.

φ = angle at which one stone will slide upon another.

In all the calculations for the wall, it is assumed that the water will stand at the level of the top of the wall, although the flow line of the reservoir is 3 feet lower. This assumption simplifies the calculations, and provides against any contingencies which might arise in freshets. It is also assumed that the bed joints are horizontal.

The batter of the face wall, and the fact that the joints of the courses there are normal to the face, make the bed joints practically inclined to the horizon, and therefore presenting greater resistance to sliding and overturning, than is assumed in the calculations.

For purposes of calculation these values are assumed —specific gravity of the masonry, $\sigma = 2.33$; the limiting angle of sliding of dressed stone upon each other, which is given by various authorities as from 31° to 35° is taken at 32°. $\therefore$ tan $\varphi = 0.625$.

For economy of material, the wall should approach in section to the wall of uniform stability, which is triangular. In this case, such a wall would have a face batter, of which tan $\alpha = 0.687$. On the other hand, on account of practical difficulties of construction, the value of α should not exceed the limiting angle of sliding of stones on moist mortar. Some experiments give this angle at 22°. The angle adopted for the wall is 21° 49′, or tan $\alpha = 0.4$.

The condition of frictional stability for the wall is tan $\theta \angle$ tan φ, φ being taken at the limiting angle for dressed uncemented stone; if Θ is made equal to φ for a cemented wall, the adhesive power of the mortar is amply sufficient to produce the required inequality; we have therefore tan $\Theta = 0.625$.

The equation of stability of position (*i. e.*, against overturning) for a wall of this form is

$$W(q \pm q^1)\, b = \frac{h^2}{6}$$

Substituting the values of the factors as given above, and reducing, we obtain for top width of dam

$$a = \frac{h}{2}\left\{\frac{1}{\sigma\ tan.\ \theta} - tan\ \alpha\right\}$$

$\therefore$, in this case $a = 0.1433\ h$

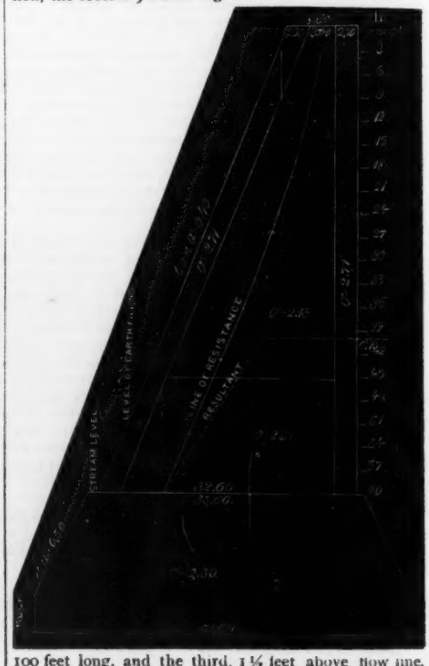
For different heights of dam, the values of a to fulfill the conditions of stability are therefore:

h.	a.	h.	a.
10	1.43	40	5.73
20	2.86	50	7.16
30	4.30	60	8.60

As built, $a = 8.6$ for so much of the dam as lies between the points where the plane of the stream level intersects the slope of the hills. Between those points and the extremities of the dam, as h diminishes rapidly, the same width of dam at top would give an unnecessary excess of material. At the same time, a less value of a than 5 feet is not advisable, that being the thickness of the two facing walls, and the least that is efficient for water-tight work. The top width of the dam is therefore reduced between the points above mentioned and the ends of the dam, by deflecting the line of the vertical face until at the ends of the dam it is five feet from the front angle, the line of the front angle being straight, and the sloping face a plane surface throughout.

Below the level of the stream, the width of the masonry was increased 1½ feet on each side, and the foundation carried to the rock with a slope on each face of 1 to 2.

As originally designed, the waste water from the reservoir when full, was intended to flow over the top of the masonry at the north-east end of the dam, the masonry there being left lower than on the rest of the wall. The overfall was arranged in three sections, one at the extreme end cut in the rock, 30 feet long at flow line elevation, the second 9 inches higher, over the masonry and



100 feet long, and the third, 1½ feet above flow line, and 70 feet long. The rock at the base of the face wall for 220 feet at this end to receive the base stones, was cut in steps, level on the face and sloping back at the angle of the wall.

For drawing off the water in the reservoir, two water ways, each 4¼ feet in diameter, were built through the dam at stream level, as shown in the Plate. Grooves for stop plank were arranged on the up-stream face of the dam, and cast-iron gates with composition facings were intended to be placed in a gate-house fitted for the purpose on the lower side. An earth embankment was built against both sides of the dam to 10 feet above the stream level. To prevent percolation of water through the masonry, it was intended that the joints on the up stream side of the wall should be raked out, and then thoroughly caulked and pointed with cement.

In 1870 when the dam was nearly completed, the control of the work was transferred by the organization of the city government under the charter of April, 1870, to a Department of Public Works, which took the place of the Croton Aqueduct Board.

The new authorities made the following changes of plan:

1st. On the water side of the dam an earthern embankment was built, 20 feet wide on top, and with slope of 5 to 2.

2d. At the foot of this slope a tower of masonry was built to above the water level. From the tower, in which are grooves for stop-plank, two lines of 36-inch pipe were laid underneath the embankment, and through the water ways, and carried several hundred feet below the dam. Stop-cocks were placed in a vault built against the upper face of the dam.

3d. An excavation was made in the rock at the north-east end of the dam, about 100 feet in width, for the waste way.

By the construction of the earth embankment, the masonry dam is changed into a retaining wall, which is impervious, and sustains a bank of earth exposed to saturation. If there could be any certainty that the embankment was impervious to water, the stability of the wall would not be endangered. But the embankment was built upon the original porous gravel 20 feet in depth, extending entirely under the bank to within a few feet of the dam; it was built by contract, and not rolled nor thoroughly rammed, but merely carted over. The material is not such as to "puddle" well. It is therefore extremely improbable that the portion adjoining the dam will be secure from the infiltration of water falling on its surface, or the penetration of the water from below, under 60 feet head in the reservoir.

If it is saturated, the pressure against the wall is equivalent to that of a fluid of the same specific gravity as the earth. If this is taken only as 1.60, the value of tan Θ becomes at the bed joint (60 feet below top of dam) = 0.996, and the resultant of pressures strike the base only 1.1 feet inside the edge, making $m = 0.034$, showing that instead of a dam amply strong to resist any pressure of water, the wall has become a retaining wall so near the limit of stability as to be, if not unsafe, at least very imprudent. Its stability now depends *entirely* upon the adhesion of the mortar, for the embankment is not watertight, and the face of the dam is constantly wet with water which has percolated the masonry for want of caulking, to the joints on the upper face.

The position of the line of resistance in the dam as built to resist a water-pressure, is shown in Fig. 2. The values of σ. *tan.* Θ and m for every three feet in height, are as follows:

Height. *h.*	Specific Gravity of the Mass. σ	Distance of the centre of Resistance from the outer Edge of Base. $m\,b.$	Condition of frictional Stability, *tan.* Θ 0.625. Actual Values. *Tan.* Θ	Condition of Stability of Position m 0.25. $m.$
3	2.483	5.12	0.065	0.523
6	2.401	5.89	0.124	0.529
9	2.442	6.41	0.177	0.526
12	2.418	6.91	0.226	0.516
15	2.410	7.33	0.268	0.503
18	2.397	7.68	0.308	0.486
21	2.384	7.97	0.344	0.469
24	2.372	8.21	0.378	0.451
27	2.362	8.40	0.408	0.433
30	2.352	8.55	0.437	0.415
33	2.343	8.66	0.463	0.398
36	2.334	8.73	0.488	0.380
39	2.338	8.78	0.511	0.363
42	2.321	8.80	0.533	0.347
45	2.314	8.80	0.552	0.331
48	2.322	8.80	0.568	0.316
51	2.328	8.78	0.583	0.300
54	2.333	7.76	0.597	0.291
57	2.337	8.72	0.610	0.278
60	2.340	8.68	0.622	0.266

Pressure per square inch of wall on foundation 38.4 pounds; resultant pressure on foundation 45.26 pounds; and pressure of the foundation on rock 38 pounds.

PLANS AND PROPOSALS FOR CONSTRUCTION.

The law with regard to work undertaken by the Croton Aqueduct Board required it to be let at public competition to the lowest bidder. On August 20, 1866, eight proposals were received and opened, The following were the prices offered:

No. of Bid.....	1	2	3	4	5	6	7	8
Class of Work.	Prices.							
A.....	$1.00	$1.00	$2.60	$0.75	$2.00	$1.00	$1.35	$2.00
B.....	0.50	0.25	0.90	0.45	0.75	0.50	0.35	0.50
C.....	10.00	2.00	3.00	0.50	2.50	5.00	4.60	5.00
D.....	30.00	60.00	78.84	27.00	40.00	108.00	66.66	40.00
E.....	15.00	25.00	21.75	20.00	12.00	27.00	47.00	22.00
F.....	11.00	14.00	17.00	11.93	9.00	10.00	40.00	18.00
G.....	8.00	7.50	6.60	9.93	10.00	10.00	11.45	17.00
H.....	6.50	7.00	6.10	7.93	8.00	10.00	11.45	16.00
I.....	0.20	1.00	0.60	2.00	0.30	2.00	2.40	1.35
J.....	1.00	2.00	1.00	5.00	2.50	2.00	2.27	4.00
K.....	0.30	1.00	1.27	3.00	1.50	2.00	3.77	0.60
L.....	20.00	30.00	22.00	20.00	20.00	27.00	30.67	28.00
M.....	10.00	10.00	5.00	5.00	8.00	10.00	6.37	3.00

A. Earth Excavation below stream, per cubic yard.
B. Earth excavation above stream level per cubic yard.
C. Rock excavation, per cubic yard.
D. Dimension cut stone masonry, per cubic yard.
E. Cut range masonry, per cubic yard.
F. Rubble range.
G. Concrete masonry below stream level, per cubic yard.
H. Concrete masonry above stream level, per cubic yard.
I. Flagging for gate-house roof, per square foot.
J. Earthen 9-drain pipe, per linear foot.
K. Cutting grooves for gates, per square foot.
L. Brick masonry in arches, per cubic yard.
M. Temporary road, per rod.

A comparison of these bids is instructive, as showing the different manner in which contractors interpret plain specifications, and the variety of views entertained as to the proportions of remunerative and unremunerative work in an undertaking of this size.

"*A.* For Earth Excavation," including all material except solid rock which required blasting, and boulders of more than one-half a cubic yard content, from the dam site below the level of the stream, and including the cost of putting the same in embankment or spoil bank, and all pumping and bailing for keeping the pit free from water.

Bid No.....	1	2	3	4	5	6	7	8
Price per cu. yd..	1.00	1.00	2.60	0.75	2.00	1.00	1.35	2.00

In these figures is seen the effect of the unknown constant for pumping and bailing. The plan for the work required the stream to be diverted from its channel near the centre of the valley, and a new channel made about 100 feet to the north-east, an embankment 10 feet above the ordinary stream level to be built around the pit on the south-west, and the excavation within this bank to be removed down to the rock. Slopes of 1 to 1 were estimated to the contractor, all caves and slides beyond that to be at his own cost.

The amount of water which might be expected to percolate the gravel was estimated by the various bidders at very different figures, their bids showing that it was considered to be worth from $0.35 to $1.70 per cubic yard of earth to take care of the water. The actual cost of the removal of water from the pits during excavation was about 45 cents per cubic yard of excavation.

"*B.* For Earth Excavation" above the level of the stream, including everything as specified under "*A.*"

No of Bid.....	1	2	3	4	5	6	7	8
Prices per cu. yd..	0.50	0.25	0.90	0.45	0.75	0.50	1.35	0.50

Of these figures, No. 2 is unaccountable and displays great lack of judgement. The excavation for the dam proper was in shallow pits, on a steep hill-side and of very hard material. It was known to be likely that the estimated quantity would be increased for embankment around the dam, the material for which would require to be selected, and to be hauled not less than 1,200 feet, and well compacted in bank. Instead of following the rule, which almost invariably holds good, that for an item which is likely to be increased, a good paying price should be offered, this bidder reduced his price on this item to less than cost. No. 3 exaggerated the cost of this work as he did of the pumping, and No. 7 evidently did not intend to lose on either "*A*" or "*B.*"

"*C.* For Rock Excavation," requiring blasting, including the removal of all boulders of over one-half a cubic yard content.

No. of Bid.....	1	2	3	4	5	5	7	8
Price per cu. yd..	10.00	2.00	3.00	0.50	2.50	5.00	4.60	5.00

The estimated amount of rock was not large, and No. 1 evidently counted on its increase. The event proved him to be right, and this item alone compensated him for a large proportion of his losses on other items. The excavation contained from 7 to 14 per cent. of boulders of over one-half cubic yard, and it was necessary to take out a considerably larger amount of rock on account of seams and shakes than the test pits gave reason to anticipate. But No. 4, which was made by a contractor of large experience is unaccountable, except on the supposition that the bidder assumed that all the rock would be in the form of boulders of from one-half to one cubic yard content and easily handled.

"*D.* For Dimension Cut Stone Masonry," every stone to be cut to exact dimensions; the beds and joints dressed to lay ¼-inch joints, and the exposed faces hammered down to an even surface.

No. of bid.....	1	2	3	4	5	6	7	8
Price per cu. yd..	30.00	60.00	78.84	27.00	40.00	108.00	66.66	40.

In this and the following masonry items, the prices offered vary with the previous experience of the contractor. No. 1 had never done similar work. Nos. 4 and 5 had never done work for the Croton Board, but were accustomed to railroad work. Nos. 2 and 3 had done some similar work for the Croton Board, and No. 6 had done a large amount of precisely similar work. No. 7's prices were high throughout. No. 8 was an engineer, who ought to have known the cost of such work better. The estimated quantity was small.

"*E.* For Cut Range Masonry."—Certain portions of the masonry around the gate-house were specified as coming under this head; the beds to be cut to lay ⅜-inch joints throughout, and the end joints for 18 inches from the face; the face to be pointed down to ½-inch projection with a chisel draft around the arris.

No. of Bid.....	1	2	3	4	5	6	7	8
Price per cu. yd..	15.00	25.00	21.75	20.00	12.00	27.00	47.00	22.00

"*F.* For Rubble Range Masonry."—The face walls of the dam were specified as to be of this class. The setting-bed to be cut to lay ¾-inch joint throughout, and the ends and top for 12 inches back from the face; the rise of the stone to be not less than 12 inches, and the beds from 2½ to 4 feet; the face to be rough with lime pitched at the arris.

No. of Bid.....	1	2	3	4	5	6	7	8
Price per cu. yd..	11.00	14.00	17.00	11.93	9.00	10.00	40.00	18.00

One important reason for the discrepancy in the prices on this item, was the title adopted in the specifications. *Rubble range* was not an ordinary term for any class of cut stone masonry, and while the specifications distinctly described the work, and the portions of the dam where it was to be be used, the use of the word *rubble* appears to have produced an impression on the minds of some of the bidders, that it was to be *random* work, laid up without regular courses. It was in fact, however, laid in courses, extending the length of the dam, the rises varying from 14 to 26 inches, and averaging 21 inches.

It was afterwards stated by some of the bidders that they had intended contesting the classification of this masonry, and that they expected to be able to procure its being rated as "Cut range," and therefore had bid a low price for it. This practice of *gambling on items* is inseparable from the method of letting the work at public competition to the lowest bidder. The only protection the engineer has, is to make the specification so distinct that no question can arise as to the classification of work. In the specifications for the dam, the description of this class of work is so explicit, that no claim for payment for it under any other classification, has been or can be allowed.

It might have been better if the word *rubble* had been omitted, as that appears to be the only basis for any misunderstanding.

"*G.* For Concrete Masonry" laid below the level of the stream; stone to be broken to not more than 2 inches in its largest dimension, nor less than ¼ inch in its smallest. Mortar to be composed of one part of hydraulic cement to two parts of sand, by measure; the proportion of mortar to stone to be such as to fill all void spaces, and be in excess of the same not more than 10 per cent. The concrete to be laid in courses of 6 inches, and well rammed. In the concrete, and to be measured as part of the same, it was permitted to lay large unwrought stones. These stones to be laid in full beds of mortar, and the surface covered with mortar ½-inch thick immediately before laying concrete around them. The price for concrete to cover all expense of bailing and draining:

No. of Bid.....	1	2	3	4	5	6	7	8
Price per cu. yd..	8.00	7.50	6.60	9.93	10.00	10.00	11.45	17.00

"*H.* For Concrete Masonry" laid above the stream level. The specifications the same as for "*G.*" This concrete to be enclosed between the rubble range walls. The large stones inserted, to average 5 feet in length and 2 square feet in cross section, and to be laid in layers alternately parallel and at right angles to the walls of the dam.

No. of Bid.....	1	2	3	4	5	6	7	8
Price per cu. yd..	6.50	7.00	6.10	7.93	8.00	10.00	11.45	16.00

The difference between the prices for "*G*" and for "*H*" is due to two causes. In laying "*G*," pumping and bailing would probably be needed. This would increase its cost. On the other hand, the larger area to be covered, and the freedom from the obstruction and interference caused by the laying of the cut stone facings ought to reduce the cost of laying the lower concrete, and the additional hoist, as the masonry rose above the surface of the ground, ought to increase the cost of the concrete above stream level. Two of the bidders estimated that these variations would counterbalance each other. The others considered that the concrete below stream level was worth from $0.50 to $2.00 per cubic yard more than that above. Actually the cost of pumping chargable to concrete was equivalent to about 18 cents per cubic yard of that below—and the hoisting to about 8 cents per cubic yard above—the stream level.

The provision permitting the insertion of large unwrought stone caused variations in the estimates. In the absence of data as to the proportion which the stone could bear to the mass, some of the bidders assumed that from two-thirds to three-fourths of the mass would be of stone, which only required to be quarried, and could be set very quickly. In practice it was found, however, that not more than one-third of the mass could be made of the large stone It was necessary that the stones should be far enough apart to allow the concrete to be thoroughly spread and rammed between them. This requires a space of not less than 12 inches between the nearest points, and with irregular stones the average distance is greater than this. When stones of irregular heights were laid, the leveling up necessary to prepare for a fresh layer of stone made the mean depth of concrete between the layers probably nearly 12 inches.

The next three items, "*I*," "*J*," "*K*," are for small quantities of special work, and the bids are not worthy of particular consideration, most of them having been made apparently at random, without regard to the cost of the work.

"*L.* For Brick Masonry in Arches" of water-ways and gate-house. This item, of some 20 cubic yards, was the only one on which the bids varied less than 200 per cent.

The contract, as awarded at this time, was for construction of the dam to within 30 feet of the top. The appropriation authorized was not sufficient for the completion of the whole dam, and the law forbade any contract to be made in excess of the appropriation. Further expenditure was authorized subsequently, and the upper 30 feet of the dam was built under a new contract, made with the same parties that built the lower portion.

(TO BE CONTINUED.)

A new kind of a fire hydrant has been put in at the City Hall, Chicago. The openings, of which there are two, are each four inches in diameter. The old style of hydrants have but two inch openings. A trial of the new one was made last week and it was found that a four inch stream could be forced clear across the street, merely by the ordinary pressure of the Water Works. There are forty of these new hydrants to be put in use in the centre of the city.

ENGINEERING NEWS.

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THE FAILURE OF THE WORCESTER DAM.

During the week we have gained more information in regard to the dam of the Worcester, Mass., Waterworks, at Lynde Brook, in Leicester, the breaking away of which we chronicled in our last issue, just as we were going to press. The description of it there given is in the main correct. The embankment was built across a ravine and made a pond of 140 acres, containing some 700,000,000 gallons. It was at first of moderate height, but, as the water supply became insufficient for the city, it was raised nineteen feet, giving a depth of over forty feet at the gate-house, and increasing proportionally the pressure at the base. An arched culvert, 8 feet wide, of about the same height, and 60 feet long, extended under the embankment and contained the water main and waste pipe, each 24 inches in diameter. This culvert is said to have been built in the natural ground, and to have been founded upon a compact gravel. Some other details will be given in an extract farther on. Each end of this culvert was closed by a stone gate-house with heavy masonry foundations, and in the lower gate-house was a 30-inch waste-gate. The face wall in cement, additional walls parallel to the face, clay-puddle and cobble-stone paving were all enumerated in our last paper. The embankment was sufficiently strong, being some forty feet wide on top. The enlargement of the dam was made in 1870-71.

After the Mill-river disaster, to allay the public apprehension in regard to this structure, warranted by certain leakage, the eminent hydraulic engineer, Mr. James B. Francis, of Lowell, Mass., was employed by the authorities to make a thorough survey and report. This report, dated June 29, 1874, is as follows:

GENTLEMEN — In pursuance of your vote of the 11th inst. I have inspected the dam of the Leicester Reservoir of the Worcester Water Works, and make the following report of the same:

I visited the dam with your Board on the 24th ult. Mr. Phineas Ball, the engineer under whose direction it was constructed, and Mr W. H. Hayward, who inspected the work during its progress, were also present, and gave me such information as appeared necessary in relation to the same. The principal feature of the dam is the embankment. This is of ample thickness, made of excellent material, and, from all the information I could gather, is well put together. In my opinion, however, it is not high enough above the level of the water in the reservoir. At the time of my visit the water was retained by flash boards on the rollway to a height of about two feet above the sill or to a height of two and a half feet only below the top of the embankment. Mr. Ball informs me that it was not originally intended to carry the water so high, but that it is done for the purpose of storing a larger quantity of water. As the necessity for this will probably continue, I think the embankment should be raised about three feet, so as to make the top of it not less than five feet above the surface of the water in the reservoir when full. The rollway, I think, is of sufficient size to discharge the surplus water, when not obstructed by the flash board. It is of course intended to take them off in case of necessity, but it is not certain that this will always be done, and to be safe at all times, I think the side walls and wing pilings should be raised an amount equal to the height of the flash boards. The channel to carry off the water from the rollway as now constructed, I think, is liable to be washed out, the paving being insufficient in case the rollway should discharge water to near its full capacity. If the channel should be washed out the rollway might go with it, which would make a breach in the dam.

The water is drawn from the reservoir by means of two cast iron pipes, two feet in diameter. They are laid in an arched gallery of masonry eight feet wide and of about the same height in the centre. Mr. Ball informs me that it was designed to have an inverted arch at the bottom, but it was omitted. On account of the great influx of water from springs a paving was substituted, which furnishes a floor on which to lay the pipes, but does not prevent the entrance of any water either from springs or the reservoir that may find its way to the bottom of the masonry as constructed. The passage of water from the reservoir to the gallery is stopped by the natural gravel bank and the puddle in contact with the masonry. By the plans shown me it appears that there is about thirty feet in thickness of gravel at the nearest point between the water in the reservoir and the bottom of the gallery. The gate-house and gallery, I am informed, are both built in the natural ground, which is a solid compact gravel. They have stood two or three years without showing any sign of failure, and I see no reason why they should not stand equally well in future, although, from the want of a suitable inverted arch to the gallery, I think it the weakest point in the bottom of the dam. I suggest that a permanent apparatus be put in the brook just below the dam to gauge the leakage of the dam and the flow from springs for the purpose of indicating any changes that may take place. The volume of water now flowing from these two sources is small, but it will be very important hereafter to have the means of knowing whether it increases or diminishes.

Respectfully submitted. JAMES R. FRANCIS.

Subsequently mill-owners on the stream below petitioned for repairs and the employing of a watchman. The water was lowered somewhat and a careful inspection kept up. A weir was put in to gauge the leakage, and it was found not to vary much at that time, But on Sept. 7, 1875, city engineer Blake called the attention of the council to the increased leakage from the pipe-way, which had augmented from 24,221 gallons a day in April of that year to 39,810 gallons in July. The flow of water was clear and therefore supposed to come from a spring under the dam. Subsequent measurements showed that the leakage was from the main dam and not from a spring under the arch. The leakage in the first part of December rose to 48,500 gallons a day. Then it fell to 39,000, and continued at that figure for a long time. On the 26th and 27th of March it rose again to 48,000 gallons; on the 28th it increased to 67,642 gallons, and on the 29th, the day before the break, it ran down again to 60,000 gallons.

With the growth of the city the water supply became scanty, a further raising of the dam was proposed and flash boards were again put on. The recent rains had also increased the inflowing water, so that a greater head of water was the result. The selectmen of Leicester had just protested against the use of flash boards, which raised the pond nearly two feet higher than was contemplated in the original construction of the dam, and they went home on Wednesday having given notice that, if the flash boards were not removed within forty-eight hours, they would take such course as the law directs to compel their removal. Before the expiration of that time the dam was gone.

On the afternoon of the 29th, the water was noticed coming up in the bottom of the archway about twenty feet from the water face, and by nightfall it flowed through the lower gate-house windows four feet wide and three feet deep. The turbidity of the water showed that the material of the dam was washing out. The gate-house was forced but the waste-gate could not be opened, owing to a jamming of the rods. The flow gradually increased during the night, through the archway and the lower gate-house; gravel, stones, hay and branches of trees were thrown in above the dam to stop the leak, which was a little to the west of the upper gate house and thirty feet below the surface. A settlement, cracking and caving of the earthwork of the dam manifested itself, showing clearly that it was being undermined. The attempt was made to draw off the pond by a side channel and to check the washing out of the dam until the body of water could be so materially lowered as to avert disaster from the mills and property below. By nine o'clock the next morning rocks and bags of hay were found below the dam, showing that the hole was increasing in size. The water level lowered but slowly. The hole on the upper side was working across the dam. By noon of the 30th the flow was diminished but the undermining still progressed. Finally, at about 5 P. M. there was a lull in the stream, probably caused by the downfall of material within the body of the dam (perhaps the lower end of the archway) causing a delusive hope that the hole was stopped in a measure; but soon a small stream made its way out of the earth just above the lower gate-house, it rapidly increased in size, the earth was speedily washed away, leaving the masonry wall exposed and unsupported. This wall resisted for a moment and then gave way, letting out a flood of water some twenty feet deep. The lower stone gate-house stood in its way and was almost instantly swept off. The upper gate-house and heavy foundation wall followed later, and the final gap was some eighty feet wide and twenty feet deep. The water fell sixteen feet in one and one half hours.

Owing to a warning of twenty-four hours, the people below had removed many of their effects, and there was no loss of life. But the destruction of dam, mills, houses, railroad embankments, etc. has caused a loss, at a low estimate, of $750,000.

From a careful consideration of all reports it appears that the failure arose from the second source which Mr. Francis pointed out, the lack of an invert below the archway. Pipe-tracks below dams have always been a source of trouble and have before occasioned dangerous breaches. The slight leakage, which had gone on for several years without damage, increased, perhaps from added pressure, and began to bring away particles of earth. The enlargement of the slight hole through which the water came and the increased flow naturally followed; the walls of the archway, and the cement wall, resting on gravel only, were rapidly undermined, but the cement wall was so heavy and firm that it stood when a considerable length must have been unsupported below. A masonry invert laid in cement would have rendered the archway secure and watertight, or the foundation of the wall should have been carried down deeper, to rock if it was there. The fact seems to have been that the dam was first built to provide a small reservoir, and foundations which were sufficient for a moderate pressure of water, have now yielded to the gradual percolation of a small stream under the increased head. The city authorities wished to avoid the expense of radical repairs and renewal, and were reassured as to the safety of the enlarged reservoir by professional and other advisers.

Where it is practicable it is always advisable to carry the waste and outlet pipes entirely through the natural ground at one side from the dam, and then to take all precautions to prevent the filtration of water along the sides of this gallery.

AMERICAN ENGINEERING AT THE CENTENNIAL.

An opportunity for the exhibition of the past history and the present condition of Engineering and Architecture in America, will be offered this season which it is hardly probable will occur again within the lifetime of a large porportion of the present members of the profession. The American Society of Civil Engineers in conjunction with the American Society of Mining Engineers and the American Institute of Architects have secured the necessary space in the Exposition Building at Philadelphia for the exhibition of maps, plans, models, &c., necessary to illustrate the progress of the several departments of their professions; committees from these societies have been actively at work for some time past collecting the materials and arranging for their reception, preservation and proper display at the Centennial Building; rooms have been engaged for headquarters of the profession while visiting Philadelphia, and invitations to the members to use these rooms have been sent out all over the country; and it may be taken for granted that everything that can be done in the time allowed, will be carried out in a style creditable to the societies named, and to the professions represented. But to do this requires money, and a large amount of it, too, and it cannot be expected that the men who do all the work are going to pay all the expenses besides. There is not an Engineer, Civil or Mechanical, Mining or Hydraulic, or to whatever department he may belong; not an Architect, nor even a

Land Surveyor, but is interested directly in securing a creditable exhibition of these professions at Philadelphia this summer, and upon everyone we would urge the importance of contributing to the expense attendant upon it. When you go to Philadelphia next July or later, you will expect to find your way to the Engineering Depart- and you will naturally feel like looking in at "Headquarters" to see if any friends or acquaintances are there; you will feel a pride in your profession as you view its achieve ments displayed in map or model, and you may be sure that you will need no passport to "Headquarters" but the acknowledgement of your brotherhood; but you will feel still more satisfied if you have invested of your means, however small, in contributing to your own and others improvement, pleasure and accommodation. Engineers and Architects are not usually troubled with the care of great riches; the most of them have but little money to spare, and especially in these times of stagnation in their professions, the committees on finance do not therefore expect large contributions, and if members of the professions represented will send in sums from *one dollar* to *five*, or more, as they can afford, the necessary amount will soon be raised. Something has already been contributed in the east; the Civil Engineers' Club of the Northwest, has voted $200 to be sent; The American Bridge Company has given $50; a Civil Engineer of this city gave $25, and other amounts large and small will doubtless be added; we hope that every Engineer, Architect and Contractor who reads this article will consiaer it a pleasure to contribute *something* and at once remit to the Finance Committee at No. 4, 23d St., N. Y. City.

Gold and Silver Stock.

The gold and silver mining stocks continue to attract some attention in this city, though the dealings in them are very restricted. Since this class of investment fell, some years ago, into disrepute, owing to the heavy losser incident to wild speculation, and the transactions of unprincipled adventurers, the mere mention of gold or silver mines was tabooed in financial circles, and to suggest to a capitalist an investment in one, was almost certain to obtain for the sanguine proposer an immediate dismissal from the august presence of $. The fabulous profits and fortunes that the "big bonanza" has made familiar the wide world over, and the insatiable human thirst for riches, have again brought gold and silver mines, if not to the front, at least so far towards it. as to rank as matters of interest to our financial "moguls," and this column is now perused weekly by thousands, with an interest that could not have been aroused only a few months ago, by any amount of special pleading.

The fact is, the usual channels for the profitable investment of capital have been closed by the long continued depression in all kinds of business, and the constant, reiterated reports of profits, exceeding the most gorgeous pictures of the "Arabian Nights," have set all who have idle capital figuring on this class of investment, and wondering whether, after all, the unfortunate "adventures," in which so much money was lost a few years ago, were not rather the result of a recklessness which, if exercised in any other class of investment would have produced the same fruit, than of any other inherent risk and unworthiness in mining itself. The result of this mental analysis with men of good judgment and clear preception, has been greatly to the credit of gold and silver mining.

The facts in the case are simple and of easy comprehension. The conditions which constitute the value of gold and silver veins, are no inscrutible secrets of nature; they are thoroughly well known. The nature of the ore, its accompanying minerals, the influence of the country rock, the very irregularities and uncertainties of ore veins, have all been studied; and though there is much, very such, yet to learn, sufficient is known to guide the expert of good judgment in discriminating between real value and wild speculation. With the exercise of the same careful investigation (neither more nor less,) in mining investment which shrewd businass men practice before investing in mortages, in city real estate, or in other familiar matters, we would rarely hear of disastrous speculations in mines. The glamor of fabulous dividends flowing from big bonanzas, warps the judgment and blinds the eyes of capitalists, and they "go into" a mining investment as they would into a game of *rouge et noir*, and with about the same results. The risk is far less in the mines than in the speculators. And our capitalists are beginning to preceive that careful investigation, and the exercise of sound business principles, produce the same results in mining as they do in other industries.—*The Engineering and Mining Journal.*

We want several copies of No. 2 and No. 7 of Vol. 3 ENGINEERING NEWS to complete setts, and will give *one month's subscription* for each copy of either of these Nos. sent us this month.

The "One Rail" Railroad.

The following is an abstract of the very interesting paper on the above subject submitted to the Civil Engineers Club by C. J. Quetil, C. E., of Camden, N. J.

Mr. Quetil expresses himself as being a strong advocate of the narrow guage system of railways, maintaining that it is far superior to the broader guage, even for roads of large traffic. But superior still to the two rail narrow guage system he considers, is the "*One Rail*" track of M. JEAN LARMANJAT a French Civil Engineer, especially when used in connection with the improved locomotive introduced by Mr. Henry Handyside, of London, England,

The writer asserts that with this system he could build a cheap transportation line and run it cheaper and in a more effective and paying way than any other, and this on any parallel, By the use of the "Gradieuter," a new surveying instrument, the cost of the survey would be largely reduced, and also the time of making it.

The road bed will be as wide as that of the narrow gauge road. The economy in rails will be very great. It will cost less not only because the length in rails will be one half, but also because lighter engines and lighter rails than those of the ordinary narrow gauge road can be used. Furthermore, I would advise a deviation from the actual mode of building railroads, and, taking advantage of the valleys and table lands, follow as far as practicable the straight line between the principal towns, regardless entirely of the sharpness of curves, and paying considerably less attention than is generally paid, to the steepness of the gradient, so as to reduce the expenses of grading, and also shorten the road. The two systems I recommend, being combined, will allow a train to go through curves of ten feet radius, and, as I have said before, to go up grades of 528 feet a mile with a very heavy load, and at a speed not less than six miles an hour on such heavy grade. I would not recommend as a general rule, the adoption of such a grade; but, if considerable expense in grading can be saved by it, and the road notably shortened, I would not hesitate to locate the road with. it.

The track is formed with only "one center rail," spiked on cross ties two feet long, and parallel to the rail are two lines of wooden sleepers or part of the road macadamized, one on each side of the rail. It is on them that the driving wheels act and the wheels of the cars roll, maintaining their equilibrium, while the center wheels, at each end of the locomotive and cars, are double flanged and run on the center rail, supporting and guiding the whole train.

On this "one rail track" the resistance of the wagons to motion has been found to be *only the four fifths* of what it is on a two rail track. The experiments were made with the dynanometer, and with the greatest care.

The system of locomotives I recommend, allows to drive at the same speed, trains considerably heavier than ordinary locomotives of same weight and same number of horse power could haul, and is the first type of the LARMANJAT locomotives. There is a second type in which the traction is made by the front center wheels on rails of light loads and light grades, and by those wheels and the side wheels driven on macadam as wheels of reenforcement when the loads and grades are heavier. The center driving wheels in this case are surrounded by bands of rubber or hard wood. To use the side driving wheels it is only necessary to let come on their shaft more of the weight of the engine to give them sufficient adhesion.

The third type of those locomotives is similar to the first one, with the addition of cog-wheels which allows the engine *to work on the same conditions as an ordinary engine*, driving very heavy loads at small speed, *and such as the engine ought to drive with the number of horse power which its construction allows it to furnish*, a great advantage over the ordinary engine, which is so constructed that if it was not because, at small speed, the resistance of the air on the cars and the resistance of the train to the motion is less than it is at great speed, it would not drive very much more at a speed of one mile an hour than at 20 miles an hour, especially if the rails are wet.

I will now by some examples show the power of these new engines. Near Paris, between the Raincy and Montfermeil, a system Larmanjat has been working from several years, on which passenge s are taken at a uniform speed of 10 miles an hour up grades 380 feet a mile and through curves 50 feet radius, and this is done with a locomotive weighing 3 tons and no more. A small locomotive of 3 tons put on a tow path hauled at 3½ miles an hour a boat loaded with 120 tons of cargo. The rail was not laid up, when the experiment was made and the driving wheels of the locomotive had no india rubber bands, and were not working through cog-wheels either. Had everything been in good order it would have hauled considerably more.

A comparison of the "one rail" and the "narrow guage" system gives the following: *One hundred and and forty locomotives of the narrow guage system to transport what 48 locomotives only of the one-rail system will transport, and those 140 locomotives being 23 h. 55 min. 48 sec. longer to make the transporation than the "one rail" engines!!*

The "one rail" system is especially valuable for towing canal boats, in corroboration of which a Commission of French Government Engineers reported as follows: "The little machine of Mr. Larmanjat is well adapted for the towage service; it is managed with the greatest facility, and may be stopped almost instantly upon signal from the captain of the towed boat. The driving wheels have wide rims, leaving no trace of their passage upon the towing path in a dry time. They should be provided with a thick band or tire of caoutchouc in order to reduce the pressure upon and consequently the abraison of the towing path during wet weather. The motor fills all the desirable conditions."

A concession was granted Larmanjat for the exclusive use of this system of towage on the Canal de Bourgogne for fifty years.

To conclude with the one-rail system, I will say that the track, including rails, fish-plates and bolts, spikes, cross-ties, longitudinal plank, and track laying with a 25 pound rail costs $2,200 a mile, while the narrow guage track costs $3,500 per mile, the rails costing $50 a ton. It is, consequently, 37 per cent cheaper than the narrow guage ordinary track and is much better. It can be put on any common road by the side of it and necessitates hardly any grading. A double track for a freight road of this system could be built with a 40 pound rail for $7,306 per mile, the rails costing $49 per ton.

A description of Mr. Handyside's locomotive is then given and the general advantages of the system commented upon. The writer concludes as follows: It is a lamentable fact that millions and millions have been expended in the construction of railroads and in an injudicious manner, because those who were put in charge of it did not know any better. We have in our body of engineers two parties as well as in politics—the Conservatives and the Radicals. The Conservatives are for keeping the system of railroads we have, however defective it may be, rather than to make any change, even for good. In this class are those who have been and are yet supposeod to be narrow guage and whose declamations have made so little impression upon the public that narrow guage roads are now built in preference to others. Their objections were fodder for the ignorant, but could not misguide the good common sense of the public.

I hope the engineers of the other party will rally around me and help to introduce the "one rail" system of railroads, and then you will also give your support to it.

The paper has been published in pamphlet form under the auspices of the Cheap Transportation Association of New York City and copies can be had by addressing Mr. Quetil at 320 Friends Av., Camden, N. J.

How to Prevent High Gas Bills.

There are various other causes of high gas bills, which the householder might well look to, but into which we cannot enter into any detail here. Prominent among these are the burners, a poor one of which may easily burn double the gas and not give half the light of one properly constructed. The ordinary type of burner, besides, burns out; and through the enlargement of its orfice, soon becomes very wasteful of gas. Another cause of waste is due to people trying to read or work by several lights located in a high chandelier or fixture instead of by one light brought near them, A single burner, one foot distant from the page of the book, will shed on that page thirty-six times more light than the same burner six feet away; or, in other words, the single burner located as first stated, will light the page as brilliantly as six chandeliers, of six burners each, hung six feet from the book. The absolute quantity of light is the same at all distances, but is spread out over an area which increases with the square of the distance from the flame; so that it obvious that lights are used very wastefully when they are placed far away from the object which they are to illuminate.—*Scientific American.*

Gas Items.

(From the Engineering and Mining Journal.)

The Rome (Ga.) Gas Works under the management of Mr. Geo. H. Gardner is making a very good gas from the resinous long leafed pine.

The prominent storekeepers of Hoboken, N. J., have given the Gas Company of that place the alternative of lower price or no gas at all. They will use petroleum.

The stock of the Citizens' Gas Co., of Brooklyn, has declined $58 per share within the past four months. This is equal to an aggregate of nearly $700,000 in the market price of the stock.

The Metropolitan Gas Co., of New York, has been awarded a judgment in the Supreme Court against the city for $133,264 which has had the effect of advancing the price of its stock $2.00 per share.

Railroad News.

The French company for testing the practicability of a tunnel under the English Channel, has two million francs already subscribed.

The Fort Dodge (Iowa) *Times* says a project is on foot and a company has already been organized to build a narrow guage road from Fort Dodge to Sibley in Osceola county.

The survey for the projected extension of the Rockford, Rock Island & St. Louis R. R., from Sterling to Rockford, Ill. has been completed.

Two hundred trains pass daily over the Pennsylvania Railroad between New York and Philadelphia. A train leaves Jersey City every seven minutes.

Twenty-three miles of the Lake Erie, Alliance & Wheeling narrow guage road are graded, bridged and tied, already for the iron. F. W. Kellogg, of N. Y., is the contractor.

The Engineer corps of the Keokuk, Galesburg & Chicago narrow guage road, arrived in Keokuk, March 20th, having completed a survey of the line between Galesburg and Keokuk. They report the route to be a very advantageous one, and the people along the line friendly to the enterprise.

Articles of incorporation have been filed with the Secretary of State at Columbus, by the Jeffersonville, Mt. Sterling & Columbus Railroad Company. It proposes building a narrow-guage railroad from Jeffersonville, O., east by north 36 miles to Columbus. With the projected Waynesville, Port William & Jeffersonville and Miami Valley roads, it will form a line from Cincinnati to Columbus. The capital stock is to be $400,000.

Manufacturers' Intelligence.

The Bethlehem (Pa.) Steel Mill is now engaged in making steel rails for the third rail on the Erie Railway to be put down by the Valley Company. These rails weigh sixty-two and a-half pounds to the yard.

Ten car-loads of machinery, including engines, boilers, etc., were shipped from St. Louis, March 31st, for San Francisco, destined for Nicholawski, Siberia, where they will be put into eight steamboats that are being built at that point for the Amoor river.

Messrs. Buff & Berger, of Boston, Mass., manufacture a tripod which is said to be a great improvement on any others now in use either home or foreign. It is novel in construction and secures great stability to the instrument attached to it. Wherever they have been used they have given universal satisfaction.

The contract for the iron work of the new court house at Quincy, Ill., has been let to John Mc Arthur, Esq. of the Architectural Iron Works of this city. The iron work for the new Sub-Treasury Building, San Francisco Cal., is also being furnished by Mr. McArthur, who during the past week has sent some eight car loads for that building to the Pacific Coast.

Frazer, Chalmers & Co. of this city are engaged building a compound engine designed to be used jointly upon the high and low pressure system, which effects a considerable saving in fuel and steam, to be placed in a new steam canal boat belonging to the Singer & Talcot Stone Co. on the Illinois and Michigan Canal. The use of an engine of this description in steam canal boats is stated to be a new feature. This establishment recently shipped to Mexico three car loads of gold and silver mining machinery.

Contractors' Intelligence.

Contractors in Ottawa, Canada, complain that they are unable to procure forms of tenders, specifications, etc., or to see the plans for the proposed Government works at Rimouski wharf.

The contract for section Nos. 6 and 7 of the Lachine Canal enlargement at Montreal, Canada, has been awarded to Mr. Charlebois, of Montreal. The contract for Sections Nos. 5 and 8 have not yet been awarded.

The contract has been let for the immediate erection of a three-story brick hotel, in Indianola, Iowa, eighty feet square. It is to be built in modern style, and will be a fine ornament to the city. The cost of the structure will be about $40,000.

At a meeting of the Board of Supervisors in Peoria, Ill. the plans of Wilcox & Miller of Chicago, for the new Court House, were finally and definitely adopted. The cost is to be $217,450 complete. After the kind of stone is decided on, and the contract let, the work will be commenced.

C H. Lane & Co., of this city, proprietors of the Western Chain Works, are shipping weekly an average of a car load of vessel chains to San Francisco, Cal. Hitherto this trade has been almost altogether supplied by English manufacturers.

J. W. Atkinson, of this city has the contract for the slate roofing, corrugated iron siding, iron shutters and doors, elevator buckets and slate work of a new elevator building, to be known as the Canton Elevator, at Baltimore, Md. The contract price for the work, which is to be completed early in June, is $12,000.

J. P. Taylor & Co., of this city, are furnishing the ornamental iron work for a fine new residence for Geo. L. Thatcher, Esq., at River Forest, Ill., and have also the contract for supplying the iron work, crestings, weather vanes, &c. for a new church at Mason City, Iowa. Benj. J. Bartlett of this city is the architect for the latter structure.

The bids for furnishing the stone for the new locks of the Sault Canal are as follows:

	Rough.	Cut.
W. A. Steele, Joliet, Ill.	$0 96	$1 45
Henry Van Vleck, Syracuse	55	83
Clough Worthington, Northamherst	49	69
Roesling Clemons, Marblehead	80	1 45
E. W. Ensign, Buffalo	79	1 00
Charles Messenger & Co., Chicago	50	72½
Edwin Walker, Cbicago	76	94
Cox & Bros., Chicago	71	91
Baldwin Quarry Co., Berea	44	62½
Henry Kerber & C. Stange, Chicago	90	1 15
Berea Stone Co., Berea	55	85
F. D. Van Wagener, Fulton, N. Y.	50	80
S. S. Vaught, Buffalo	60	1 25
F. T. Sherman, Chicago	...	1 11
Wm. Patrick, Fulton, N. Y.	50	80
Boyle & Roach, Cincinnati	67	1 28
Robinson & Spaulding, Sauk Rapids	1 57	1 80

The bids as given above will be sent to Chief Engineer Humphreys, and the contract will be awarded in about two weeks from April 1st.

The proposition of F. B. Loomis, New London, Conn. J. E. Redfield, Essex, Conn., and H. B. Crosby, New York City, to construct the Marquette Railroad, was accepted, March 30, by the Board of Contract of the State of Michigan swamp lands. The papers and bonds are to be signed at Detroit, April 12. The route as surveyed is 147 miles long. Starting at the narrowest point of the straits, it runs northwest, and strikes Chippawa Co. in township 44 north, range 6 west, leaving the county on the west side of said township and entering it again in the township 46 north, range 12 west, bearing thence very nearly west. The grant of State swamp lands, in counties of Mackinaw, Marquette, Chippewa and Schoolcraft, covers nearly 1,300,000 acres. The work will be immediately commenced in the spring and it is to be completed by Dec. 31, 1877. The buildding of this road, it is thought, will involve the early completion of the Jackson, Lansing and Saginaw branch of the Michigan Central, giving through railway connection of the Lower Peninsula with the chief towns and rich mineral districts of the Upper Peninsula.

Proposals for Contracts.

BRIDGES.

Commissioners' Office,
Cincinnati, Hamilton Co. O.

Proposals will be received at this office until Saturday, April 29th, 1876, at 12 o'clock M., for masonry for a bridge arcoss Dry Fork of Whitewater on the new county road leading from New Haven to Venice in Crosby township. Specifications con be seen at this office. Also for a Superstructure at the same place, wood or iron, 140 feet clear span and 18 feet clear roadway. Also, for taking down, removing and rebuilding Superstructure on new abutments. Payments will be made in Hamilton County Bonds bearing interest at 7 per cent. Joseph B. Humphrey, *Auditor.*

Notice is hereby given that the Commissioners of Grant County, State of Indiana, will, on Friday, the 5th day of May, 1876 let the contract for the building of a bridge across the Mississinewa River at the point known as "Sutton's Ford." Plans and specifications on file in my office. By order of Board. Jos. W. Stout, *Auditor Grant* Co. Marion, Ill.

Proposals will be received by the Board of Commissioners of Monroe County, Indiana, at the Auditor's office, at Bloomington, until 1 o'clock, Wednesday, April 26th, for the building of stone abutments for bridge, and iron fence around the court-house square. Plans and specifications can be seen at the Auditor's office. Cash payments. James F. Manley, *Auditor Monroe County.*

The Supervisors of the town of Milton will receive proposals until Friday, April 28, at 12 o'clock M., for building a bridge in Road District No. 2, near J. E. Elias' mill, on the road from Roscoe to Mantorville. The materials, with the exception of the iron will be furnished on the ground. The mason and carpenters' work will be let separate or together. The specifications may be seen at the town clerk's office. J. Cramond, *Town Clerk.*

Great Western Railway of Canada. Sealed Proposals are requested for the building of a Stone Bridge under this railway, near Copetown. Plans and specifications may be seen at the office of the Chief Engineer, Hamilton. Tenders addressed to the Treasurer of the Great Western Railway Company, Hamilton, will be received until the 15th of April. F. Broughton, General Managers Office, Hamilton, Ontario.

Proposals will be received at the County Clerk's Office, in the city of Galena, Ill., on Friday, the 28th day of April, for the building of a stone bridge near the village of Hanover. Plans and specifications can be seen at the County Clerk's Office in the city of Galena and at the post office in the village of Hanover. William Howarth, Henry Chapman *County Bridge Commissioners.* John L. Phillips, C. N. Hammond, *Commissioners for the Town of Hanover.*

Commissioners' Office,
Cincinnati, Hamilton Co. O.

Sealed proposals will be received at this office until Saturday, April 29th 1876, at 12 o'clock M., for repairing the Superstructure of the California Bridge over the Little Miami River, on the California and New Richmond Turnpike, between Spencer and Anderson townships. Specifications can be seen at this office. Jos. B. Humphreys, *Auditor.*

City Commissioners' Office,
Baltimore, March 30, 1876.

Proposals, plans and specifications will be received at this office until Thursday, 27th April, at 12 M., for furnishing the materials, for and construction of an iron trussed bridge over Jones Falls on the line of John Street. The bridge to be composed of 4 trusses. The outside lines to be 8 feet from center of truss to the line of sidewalk; the intermediate lines to be 16 feet, 8 inches from center to center. The horizontal bracing to consist of cross struts and diagonal rods, at top and bottom cords. Length between masonry, 136 feet; depth of truss, 18 feet; width of roadway, 40 feet; width of sidewalks (each) 13 feet; whole width of bridge from out to out, 66 feet. For full particulars see Baltimore *Gazette*, April 1st. N. B.—Ordinance 43, of March 1875, provides "that it shall be inserted in the contract and to be part thereof, to be secured by the bond given, that the contractor shall have the work for said bridges done at the city of Baltimore, by mechanics and workmen who are citizens of Baltimore city, and the work to be done, and all the materials that can be furnished by Baltimore contractors." John E. Toole, *Clerk to City Commissioners.*

BUILDINGS.

Proposals will be received by me for the building of a School House, in York Township, Tama County, Iowa, until Monday, May 1. The specifications can be seen at my office one half mile west of Redman. Amos Rogers, Irving, Iowa, *Secretary of School District.*

There will be offered for sale on Saturday, the 22d day of April to the lowest responsible bidder, the contract for the erection of a school house in sub-district No. 3 (Fairview) in the district township of Squaw, Warren County, Iowa, Sale to begin at 2 o'clock sharp. Plans and specifications can be seen at the office of the county superintendent and at the residence of Samuel Gregg, in district No. 3. The foundation will be sold separate. By order of the Board of Sub Directors. Sam'l. Gregg, *President.*

Proposals will be received until Saturday, April 22d, at the office of the Secretary of Independent School District of Center Junction, Jones County, Iowa, for building and completing a school house in said district. Plans and specifications can be seen at the office of the Secretary, at Center Junction. J. C. Houser *Secretary*, Center Junction.

Tenders will be received until noon, April 13th, for the erection of One Twelve Room.—Ward of St. David—Messrs. Langley, Langley & Burke, Architects, 31 King Street, west. One Twelve Room School.—Ward of St. Patrick.—Messrs. Stewart & Stickland, Architect, 11 and 12 Masonic Building, Toronto Street —And for eight additional rooms, Wellesley Street School,—Ward of St. John—Messrs. McCaw & Lennox, Architects, Imperial Building, 30 Adelaide Street east. Plans and specifications can be seen, and all information obtained, at the offices of the above architects, at Toronto, Ontario. By order. W. C. Wilkinson, *Secretary School Board.*

Proposals will be received until the 1st of May by the Secretary of Laurel Hill Independent School District, Greenfield township, (P. O. address Martelle,) for building and completing a school house in said district. Plans and specifications can be seen at the *Eureka* office, Anamosa, Iowa, and at Dr. Belden's store, Martelle. S. C. Kemp, *Secretary.*
Martelle, March 29, 1876.

Proposals for the erection of a School House in the Independent District of Flint River Township, County of Des Moines, State of Iowa, will be received by the undersigned, at his office, in said school district, until the 29th day of April, at 1 o'clock P. M. John H. Sudbrack, *Secretary of the Board of Directors.*

Proposals for the erection of a School House, in Sub-District No. 10 in the District Township of Beaver, County of Butler and State of Iowa, will be received by the undersigned, at his residence, in said township, where plans and specifications may be seen until Saturday, April 22d at 1 o'clock P. M. P. Wood, *Sub-Director.*

National Home For Disabled Vol Soldiers,
Northwestern Branch, near Milwaukee, Wis.
Commandant's Office, March 31, 1876.

Sealed proposals will be received by the undersigned until 12 o'clock M., Monday, 17th April, for the construction of additions to the buildings of this branch, according to plans and specifications on file in this office. Edward W. Hicks, *Commandant*

The State House Commissioners will receive proposals until noon of May 4th, 1876, to furnish in place, complete, the metallic cornices, caps and covering of the upper dome, including the lantern, and the ornamentation of the Mansard roof, turrets and dome. Separate bids will be received: first, for the roofing and cornice work; second, for the ornamentation. The plans and specifications of said work may be seen and printed specifications will be furnished, on application at the office of A. H. Piquenard, Acting Architect, in the new State House. Jacob Bunn, John T. Stuart, Jas. H. Beveridge, *Commissioners.*
Springfield, Ill., April 3d 1876.

Proposals will be received for the erection of a Court House at Center City, in the County of Chisago, Minn., in strict compliance with the plans and specifications made by and signed "A. L. Gray," adopted by the Board of County Commissioners of the said county, now on file at the County Auditor's office, until the 18th day of April. The building to be completed on or before the 10th day of October. Otto Wallmark, *County Auditor.*

Proposals will be received by the undersigned, Trustee of Green township, Morgan County, Ind., until the 1st day of May for the purpose of erecting a Brick School House in said township, according to specifications now in his posession. Terms of payments made known on application. W. C. Cain, Martinsville *Trustee of Green Township.*

Proposals for the erection of a School House in Sub-District No. 2, and one School House in Sub-District No. 6, in the township of Cedar, in the county of Mitchell, and state of Iowa, will be received by James Temple in Sub-District No. 2, and Ole O. Haugerud in Sub-District No. 6, until 1 o'clock P. M. on Saturday the 6th day of May. Plans and specifications will be seen at Jas. Temple's and Ole O. Haugerud at Osage, Iowa. By order of the *Board of Directors.*

MISCELLANEOUS.

Proposals will be received by the Common Council, of the city of La Fayette, Indiana, up to Monday evening, April 17, for the improvement of Purdue Street from Sixteenth Street to the Dayton Gravel Road, and for the improvement of the Alley running from Eleventh to Twelfth Street, between North and Brown Sts. Specifications for said work can be seen at the office of the City Engineer. By order of the Common Council. Jacob Kurtz, *City Clerk.*

St. Lawrence Hall,
W. W. Commissioners Office,
Toronto, 1st April, 1876.

Tenders will be received at this office until Monday, 10th April at 4 o'clock P. M., for 100 tons of lead pipe, best soft English pig as follows: ¾ inch, 48 tons; ⅝ inch, 32 tons; ¾ inch 6 tons; 1 in 4 tons. Specifications may be seen and any information obtained upon application at the office of the Chief Engineer, P. A. Peterson. John Boyd, *Secretary.*

Proposals will be received up to 12 o'clock M., Friday, the 21st day of April, for grading and paving the full width of the carriage way of Ottawa Street with boulder stone, together with necessary curbing, gutters, crosswalk, etc., from the northeast line of lots 17 and 18, Receiver's Addition to the southerly end of the Nicholson pavement on said Ottawa Street. Plans and specifications can be seen at the office of the City Civil Engineer. G. W. Merrill, *City Clerk*, Toledo, Ohio.

Office Wheeling Gas Works,
April 1st, 1876.

Sealed proposals for furnishing and delivering in Wheeling, Gas Pipe and Special Castings, will be received at this office up to April 19th, 1876, at 5 o'clock P. M. All bids for furnishing pipe to specify the weights and thickness, and must be bid for by the foot, the pipe to be cast vertically, and to be of uniform thickness and weight. Bids for special castings to be made by the ton. Specifications for same will be furnished at this office, and all bids must state the time of delivery of all the pipe and other castings proposed to be furnished. All material furnished to be paid for in cash upon the completion of the contract, trustees reserving the right to reject any and all bids. The pipe to be furnished is to be No. 1 cast iron gas pipe, and is to be of the size and quantities following, viz.: 5,000 feet of 8 inch cast iron gas pipe; 5,500 feet of 6 inch; 18,000 feet 4 inch; 2,000 3 inch. By order of the board of trustees. I. L. Maxwell, *Secretary* Board of Trustees.

Proposals will be received at the office of the City Clerk of Columbus, Ohio, until Saturday, April 29th, at 12 o'clock, noon, for laying an Asphalt pavement on North High Street, from Naghten Street to the north corporation line, in accordance with plans and specifications on file in the City Engineer's office, in Columbus. Said pavement will contain 50,000 yards, more or less, and shall be bid for by the square yard. Also, for furnishing and setting curb on said North High Street. Curb to be not less than five inches thick, eighteen inches deep, and three feet in length, dressed on top, face and sides, joints to be dressed eight inches deep. Curb to be either Berea, Amherst or Sunbury stone. Bidders must specify the kind of stone they propose to furnish. H. M. Neil, *Secretary.*

Proposals for the grading, curbing and planking of Franklin Street, Michigan City, Michigan, between the center line of Michigan and the south line of Eighteenth Streets will be received until 7 o'clock P. M. of the 10th day of April, at the Clerk's office. Sam. M. Eddy, *City Clerk.*

City Commissioner's Office,
Baltimore, March 31, 1876.

Proposals will be received at this office until Wendesday, 12th April, at 12 M., to grade, curb and pave Calhoun Street, between La Fayette Avenue and Mosher Street. John E. Toole, *Clerk to City Commissioners.*

Proposals will be received at the office of the City Clerk of Columbus, Ohio, until Monday, April 17th, at 12 o'clock M., for gradiug the roadway of North High Street from Naghten Street to Fifth Avenue. Said grading shall be done according to plans and specifications on file in the City Engineer's office, Columbus. H. M. Neil, *Secretary of Board of Commissioners.*

Proposals will be received until 12 M., on the 20th day of April First.—For ventilating the present cells in the Penitentary, at a cost not exceeding $3,500 for work, labor, material, &c., according to the plans and specifications submitted by H. P. McDonald Architect, on file with the Commissioners of the Sinking Fund. Second,—For Plans and specifications for building additional cells on the Penitentiary grounds, according to an appropriation $25,000 therefor. Plans and specifications may be examined at any time prior to the award at the Executive office, Frankfort, Ky. Address D. Howard Smith, *Secretary.*

Proposals will be received at the office of the City Clerk until Tuesday, the 11th day of April 1876, for the brick, stone, timber and other materials, comprising the west end market house, at Fort Wayne, Indiana, with the exception of the bell. Said material to be removed from the ground on or before the 15th day of May next. J. B. White, M. Baltes, C Schaffer *Committee* on Public Grounds and Buildings.

O. B. GREEN, *Pres.* THOS. BURGESS, *Supt.*
C. H. ATKINS, *Sec. and Treas.*

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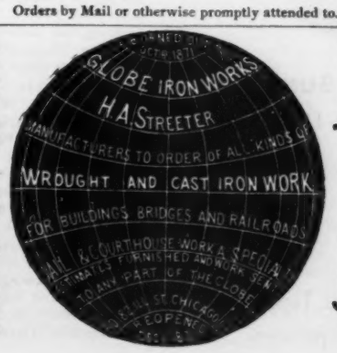
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TRADE MARK.

REG. JUNE 8TH 1875.

Without decreasing size of any part of our "Engineers' Transit" we have reduced the weight one-half. An ordinary Transit Telescope magnifies from 10 to 12 diameters, our new Transit Telescope (length 10½ inches, shows objects erect and not inverted) magnifies 28 diameters and will read time on a watch-dial at 985 feet. For description of our new Mining Transit (weight 5½ lbs.) and Plummet Lamp, see Van Nostrand's Engineering Magazine, June, 1873.

Extract from report of Committee of Civ. Engrs. appointed by Franklin Inst. to examine H. & B.'s new Transit [Dec. 1871]: "It exhibits several novelties of construction which, in the opinion of the committee, render it superior to those now in use, and in its opinion the deviations which they have made from the common styles of Transit are decided improvements."

JOHN C. TRAUTWINE, Chairman.

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